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CLAIMS

WHAT IS CLAIMED IS:

1. A coated substrate, comprising:

an antitarnish layer deposited on a substrate in an amount effective to prevent tarnishing of said coated substrate; and

an outer layer deposited onto said antitarnish layer, said outer layer comprising tin or tin alloys having at least 50% by weight tin.

2. The coated substrate of claim 1, wherein said antitarnish layer comprises an antitarnish agent selected from the group consisting of zinc, chromium, indium, phosphorous, manganese, boron, thallium, calcium, silver, gold, platinum, palladium, and combinations or alloys thereof.

3. The coated substrate of claim 1, wherein said antitarnish layer has a thickness of between 5 and 2500 Angstroms.

4. The coated substrate of claim 3, wherein said antitarnish layer has a thickness of between 5 and 1000 Angstroms.

5. The coated substrate of claim 4, wherein said antitarnish layer has a thickness of between 5 and 500 Angstroms.

6. The coated substrate of claim 1, wherein said outer layer has a thickness of between 10 and 1000 microinches.

7. The coated substrate of claim 6, wherein said outer layer has a thickness of between 10 to 400 microinches.

8. The coated substrate of claim 1, further comprising a barrier layer disposed between said substrate and said antitarnish layer.

9. The coated substrate of claim 8, wherein said barrier layer comprises an element selected from the group consisting of nickel, tin, iron, cobalt, copper, and combinations and alloys thereof.

10. The coated substrate of claim 1, wherein said outer layer further comprises a friction-reducing material selected from the group consisting of polyimide, polyamide, polytetrafluoroethylene, silicon carbide, aluminum oxide, tungsten carbide, molybdenum disulfide, and combinations thereof.

11. The coated substrate of claim 1, wherein said coating is in a heat treated condition and has a coefficient of friction in the range of from 0.1 to 0.3.

12. The coated substrate of claim 1, wherein said substrate comprises copper or a copper alloy.

13. A coated substrate comprising a coating on a substrate, said coating having a first surface and a second surface, said second surface positioned adjacent to said substrate, and comprising:

a metal layer comprising tin or tin alloys having at least 50% by weight tin; and

a concentration gradient of antitarnish agent diffused into said metal layer, said concentration gradient having the highest concentration of said antitarnish agent at said second surface, said antitarnish agent present in said coating in an amount effective to prevent tarnishing of said coating;

and wherein said coating has a thickness between 10 microinches and 1000 microinches.

14. The coated substrate claim 13, wherein said antitarnish layer comprises an antitarnish agent selected from the group consisting of zinc, chromium, indium, phosphorous, manganese, boron, thallium, calcium, silver, gold, platinum, palladium, and combinations or alloys thereof.

15. The coated substrate claim 13, wherein said coating has a thickness of between 10 to 400 microinches.

16. The coated substrate claim 13, wherein the amount of antitarnish agent in said coating ranges from 0.001 to 5 wt%, based on the total weight of said coating.

17. The coated substrate claim 16, wherein the amount of antitarnish agent in said coating ranges from 0.005 to 3 wt%, based on the total weight of said coating.

18. The coated substrate claim 17, wherein the amount of antitarnish agent in said coating ranges from 0.01 to 2 wt%, based on the total weight of said coating.

19. The coated substrate claim 13, further comprising a barrier layer disposed between said second surface and said substrate and said antitarnish layer.

20. The coated substrate claim 19, wherein said barrier layer comprises an element selected from the group consisting of nickel, tin, iron, cobalt, copper, and combinations and alloys thereof.

21. The coated substrate of claim 13, wherein said outer layer further comprises a friction-reducing material selected from the group consisting of polyimide, polyamide, polytetrafluoroethylene, silicon carbide, aluminum oxide, tungsten carbide, molybdenum disulfide, and combinations thereof.

22. The coated substrate of claim 13, wherein said coating is in a heat treated condition and has a coefficient of friction in the range of from 0.1 to 0.3.

23. The coated substrate claim 13, wherein said substrate comprises copper or copper alloy.

24. A method of forming a coated substrate, comprising the steps of:

(1) depositing an antitarnish layer comprising an antitarnish agent onto a substrate, said antitarnish layer

deposited onto said substrate in an amount effective to prevent tarnishing of said coated substrate following diffusion of said antitarnish layer into said metal layer;

(2) depositing a metal layer onto said antitarnish layer, said metal layer comprising tin or tin alloys having at least 50% by weight tin; and

(3) diffusing said antitarnish layer into said metal layer to form a concentration gradient of said antitarnish agent within said metal layer, said concentration gradient having the highest concentration of said antitarnish agent at said substrate, to form said coated substrate.

25. The method of claim 24, wherein said antitarnish agent is selected from the group consisting of zinc, chromium, indium, phosphorous, manganese, boron, thallium, calcium, silver, gold, platinum, palladium, and combinations or alloys thereof.

26. The method of claim 24, wherein said deposited antitarnish layer has a thickness of between 5 and 2500 Angstroms.

27. The method of claim 26, wherein said deposited antitarnish layer has a thickness of between 5 and 1000 Angstroms.

28. The method of claim 27, wherein said deposited antitarnish layer has a thickness of between 5 and 500 Angstroms.

29. The method of claim 24, wherein following said diffusion step, the amount of antitarnish agent in said metal layer ranges from 0.001 to 5 wt%, based on the total weight of said metal layer following said diffusion step.

30. The method of claim 29, wherein following said diffusion step, the amount of antitarnish agent in said metal layer ranges from 0.005 to 3 wt%, based on the total weight of said metal layer following said diffusion step.

31. The method of claim 30, wherein following said diffusion step, the amount of antitarnish agent in said metal layer ranges from 0.01 to 2 wt%, based on the total weight of said metal layer following said diffusion step.

32. The method of claim 24, wherein said metal layer has a thickness of between about 10 and about 1000 microinches.

33. The method of claim 32, wherein said metal layer has a thickness of between about 10 and about 400 microinches.

34. The method of claim 33, wherein said metal layer has a thickness of between about 20 and about 80 microinches.

35. The method of claim 24, further comprising the step of depositing a barrier layer onto said substrate prior to said step of depositing said antitarnish layer.

36. The method of claim 35, wherein said barrier layer comprises an element selected from the group consisting of nickel, tin, iron, cobalt, copper, and combinations and alloys thereof.

37. The method of claim 24, wherein said substrate comprises copper or a copper alloy.

38. The method of claim 24, wherein said coated substrate has a coefficient of friction in the range of from about 0.1 to about 0.3.

39. The method of claim 24, wherein said diffusing step comprises heating said coated substrate at a temperature of between 240°C and 600°C.

40. The method of claim 24, wherein following said diffusing step, said coated substrate is heated.

41. The method of claim 40, wherein said heating step comprises heating said coated substrate at a temperature of between about 150°C and 200°C for between about 1 and about 75 hours.